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ABSTRACT

Due to historical reasons and urbanization progress, demographic development change has promoted China to enter an aging society and the elders' demand for medical care and health care has increased rapidly. Meanwhile, the rapid development of information technology is driving the "Smart Care for the Elderly" model which is based on the Internet and regards the internet of things as the medium which has gradually developed into a complete a system, and a series of solutions have been formed. This paper started with the analysis of China's elderly population status quo, combed academic studies on domestic and foreign "Smart Care for the Elderly" and applications in recent fifteen years and explored how to build a comprehensive "Smart Care for Elderly" solution with improved functions which incorporates such key elements as information technology and social sciences.

Keywords: Aging, Smart Care for Elderly, Information Technology

Nowadays, China has entered the aging society, facing the problem of "getting old before getting rich" and "aging in a fast pace". The net number of the elderly increased by 8 million to 12 million every year, among which the number of the oldest old increases especially quickly. In February 2011, the Ministry of Civil Affairs announced the "12th Five-Year' Plan for Construction of Social Elderly Care Service System" which mentioned "9073" nursing model. According to the "9073" nursing model, 90% of the elderly will be nursed at home, 7% in communities and 3% in institutions. The issue of elderly care has become a hot topic among the society. There are increasingly prominent problems facing elderly care, such as conservative consumption concept of the elderly, small profit margin for elderly care enterprises, social service resources barriers, lack of a service quality supervision and assessment system, severely insufficient coordination between medical health service and elderly care service, as well as unimproved supporting systems such as insurance, taxation and finance.

The government attaches great importance to problems caused by the aging society. According to "Instruction Opinions about Promoting Combination of Medical Health Service and Elderly Care Service" published by the State Council, by 2020, resources of medical health service and elderly care service will be shared orderly, and a comprehensive network integrating medical health service and elderly care service, covering urban and rural areas, functioning properly and sustainablely will be formed by then[1]. Under such social conditions, the academic circle gradually initiates studies on "smart care for the elderly".

STATUS QUO ANALYSIS OF CHINA'S AGED POPULATION

General Growth in Average Life Span

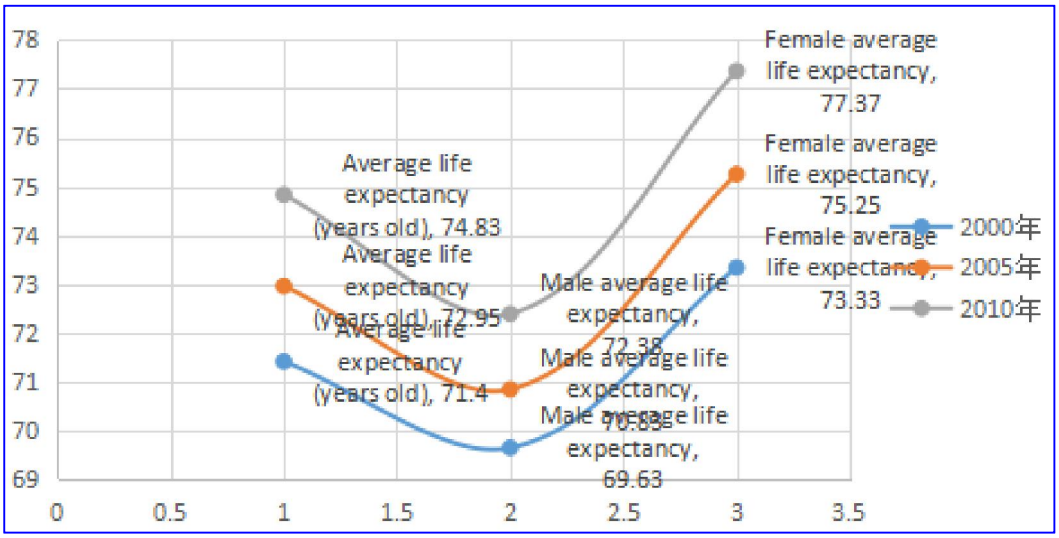

Figure 1: Average Life Span of Population from 2000-2010 (Data source: State Statistics Bureau. Note: Average life expectancy was calculated according to population census data)

According to Fig. 1, the average life span of Chinese population increases by two to three years old every five years. With rapid development of high-tech means of medical service, the number of long-life population will be growing, which will drag China into its aging society.

Fast Increase in the Proportion of Aging Population

In order to have a more graphic view of population structure and development conditions of different age stages, we adopted annual statistical data of the State Statistics Bureau to work out a radar map in terms of the age structure of China's population in recent 20 years:

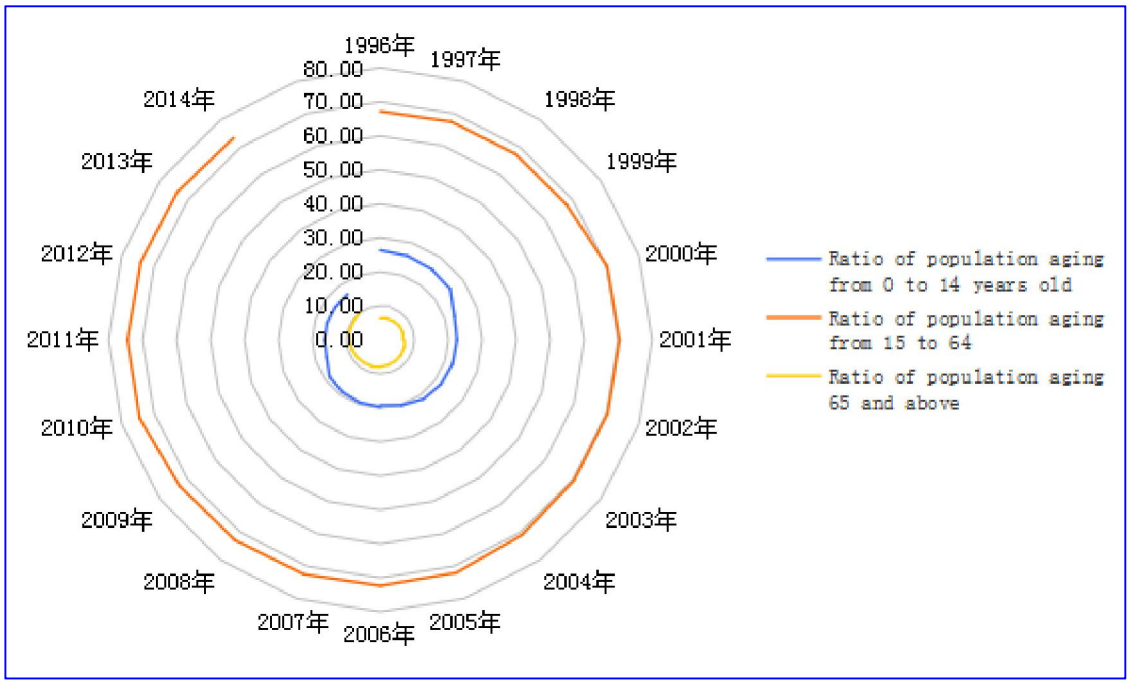

Figure 2: Age Structure Radar Map of Population in Recent 20 Years
(Data source: State Statistics Bureau (retrieved in June 2016))

Thereinto, the population data in 1981 and before came from household statistics; data in 1982, 1990, 2000 and 2010 was inferred based on population census of that year; data of other years was calculated based on annual population sample survey. The total population and the population categorized by gender included military personnel in active service. Military personnel in active service were deemed as urban population.

According to Fig. 2, in recent 20 years, the 0-14 year-old population curve took on an apparent inward trend. At that stage, it's a fact that population showed negative growth. Population aging from 15 to 64 was the major labor force and the data curve demonstrated smooth and slightly inward feature, being relatively stable; the data curve of population aging 65 and above manifested an extremely obvious outward feature, indicating that the increase in the aging population ratio was ascending, which was worth attention.

Anxious Mood for Elderly Care

According to Blue Book of China's Society: Society of China Analysis and Forecast 2016, young and middle-aged groups who were born in 1970s and 1980s are especially ancious about the elderly care, medical care and housing problem. And they are less satisfied with social security than other groups. 33.9% of them hold that social security in nursing and other aspects was not fair or extremely unfair [2] . Their anxiety is apt to trigger social instability, thus we need to attach great importance to it.

Severely Insufficient Function in Whole-Society Elderly Care

By the end of 2014, the number of population aging 60 and above exceeded 212 million, accounting for 15.5% of the total population, which surpassed the total population of Japan. The number of disabled and half-disabled old people reached about 40 million. The demands for medical care, nursing and rehabilitation services quickly rose, thus bringing about immense challenge to China's elderly care and medical systems. According to estimation of OECD, the per capita medical cost of population aging over 65 was about two to eight times greater that of population aging below 65. Rehabilitation and nursing demands as well as demands for nearby service and door-to-door service would go up dramatically. In the past ten years, the ambulatory treatment utilization rate of the elderly has increased to 49% from 27%, and the hospitalization utilization rate and nursing demand quantity have been rising as well. The ratio of disease burden of the elderly increased to 3.4% in 2013 from 2.1% in 1993. The total sanitation costs accounted for about 50% [3]. The long-term nursing system for disabled and dementia old people is still at an early stage. As a result, it faces many problems such as inadequate theoretical studies, limited special

policies and regulations, non-systematic service items and to-be-established talent team. All these have restrained development and improvement of long-term nursing system [4].

STATUS QUO ANALYSIS OF DOMESTIC AND FOREIGN STUDIES

From 2015 to 2035, China will enter its rapid aging stage. The aging population will increase to 418 million from the current 212 million. Accelerated aging has led to structural shortage in labor force. Smart care for elderly was proposed by British Life Trust Fund for the first time, also known as "full smart senile system". The system used technologies such as sensor technology, data processing technology, web technology and mobile internet technology to transform traditional elderly care service model and management means, provide sufficient life care, medical nursing and spiritual consolation for the elderly and make them enjoy high-quality and highly comfortable elderly care services [5]. Detailed research fields are as follows:

Studies on the Concept, Connotation and Pattern of "Smart Care for the Elderly"

Studies on the concept, connotation and pattern of "smart care for elderly" were mainly conducted by Chinese scholars: ZUO Meiyun, et. al (2014) put forward for the first time the concept of "smart home elderly care", explored meanings and patterns of smart elderly care, and analyzed opportunities and problems in the development course of smart elderly care [6-7]. LIU Jianbing (2015) further explained the concept of smart elderly care. He held that realizing social and smart elderly care service was an inevitable choice to solve difficulties such as structural shortage in elderly care service resources and labor-intensive elderly care under the quick population aging background of China [8]. Bierhoff I, et. al (2015) maintained that comprehensive nursing system was a complicated ecosystem and organization, nursing staff, technicians and those being nursed were interdependent; varied demands of those being nursed shall be highlighted [9]. ZUO Meiyun, et. al (2016) viewed community service for home elderly care from the perspective of smart elderly care, and concluded that abilities such as information technology building platform, information integration, decision-making support and standard service could help with benign circulation of community elderly care subjects [10].

Studies in the field emphasized humanistic and social sciences and followed the vein of "smart home elderly care-smart community elderly care-public economics-formulation of government policies". What's worth mentioning was that the concept of "smart care for elderly" proposed by scholars such as ZUO Meiyun for the first time in 2014. They started with demand theory and information technology to organically integrate different life demand hierarchies of the elderly and services provided by the smart elderly care platform or components of the platform. In addition, they explained the connotation of "smart elderly care" clearly and was of milestone significance to studies of following scholars.

Studies on Information Technology Application in "Smart Care for the Elderly"

Foreign scholars started early studies on technical aspects: Mynatt E D, et. al (2001) maintained that the elderly's routine work could be supported by computer technology and enhancement of complicated computing ability [11]. Tapia E M et. al (2004) designed home use sensor equipment in his study to identify human body activities with a detection precision ranging from 25% to 89% [12]. Rammal A et. al (2008) monitored activity, exercise and physiological information through data dynamics in mathematical modeling. He concluded that the system was adaptable and could be duplicated on large scale [13]. Chung S B et. al (2012) worked out an interface system which was composed of language and exercise identification system in this study for disabled people and old people who couldn't use electronic equipment [14]. Barolli L et. al (2013) designed Smart Box to integrate it with P2P system so as to monitor and control activities of patients and the elderly [15]. Jalal A et. al (2014) studied simulated smart indoor activity data set and MSR Daily Activity 3D data set which could be applicable to the monitoring system for all kinds of old people [16]. Mccarthy M et. al (2015) conducted a study on the consistence between motion sensor data collection and actual conditions. The studied showed that motion sensor data collection needed to be supported by advanced nursing science [17]. Syed Misbahuddin et. al (2016) developed a health nursing system based on the internet of things to help the disabled or the elderly [18]. Burns N B et. al (2016) proposed a SmartCare project which was designed, developed and assessed for the living environment of the elderly, such as three-dimensional and visualized smart apartment (VISMA) and Z-Wave home automatic technology (ZAPS) that provided daily assistance [19].

Chinese scholar ZHU Xiaofeng (2013) applied mobile internet and smart terminal technology to elderly care service through Android technology and established a menu-like community smart elderly care platform for old people [20]. ZUO Meiyun (2014) proposed games for smart elderly care from the perspective of hierarchy of needs [21]. SUN Yimin et. al (2015) designed a smart supporting platform based on care assistive robot which integrated sensor, RFID, RSSI and other hardware facilities as well as robot service system [22]. The utility model patent of CHEN Junbo (2015) was a kind of smart care information equipment based on cloud platform [23]. ZHU Jingyi et. al (2016) combined technologies such as internet of things, RFID and sensor to work out a kind of smart care service platform on the basis of wearable devices [24].

To sum up, relevant domestic and foreign technological studies focus on such fields as "sensor, data mining, cloud computation, software application, smart equipment and data interface". In recent years, with rapid development of information technology, new technologies such as mobile internet, virtual reality, augmented reality and mix reality have appeared and been applied to smart elderly care solutions based on the internet of things. .

"Smart Care for the Elderly" Solution and Case Study

In terms of smart elderly care solution design and application, well-known companies IBM and NEC, as pioneers, advocated

and introduced a whole set of smart elderly care solutions. IBM put forward the concept of "smart earth" [25] in 2010 and later on proposed the concept of "smart medical care". It's oriented towards a greater health system covering multiple aspects such as medicine, nursing, rehabilitation and elderly care. The smart elderly care service system of IBM was a smart elderly care and nursing system which centered on old people and was characterized by coordinated services, whole services, on-demand services and real-time perception [26].

NEC utilized its informationized management experience in Japan's elderly care industry and introduced a smart elderly care information management platform for elderly care institution operators, NEC i-Care Platform. It's officially launched in China in 2011. Now it's applied in institutions such as a large elderly care chain organization in Beijing and Shijingshan Elderly Care Home. NEC smart elderly care solution in 2016 integrated technologies such as big data, cloud computing and sensing, was equipped with systems such as NEC precise positioning system, face recognition system and PBX call center as well as hospitals' HIS, LIS and PACS systems. It's a smart elderly care operation informationization solution of "internet + smart elderly care + combination of medical care and elderly care". In June 2016, NEC tested its home elderly care informationized management platform which was officially released in August [27].

In China, the application of "smart care for the elderly" started with community service for home elderly care in 2010: in 2010, Jiangsu Economic News reported that NandaSoft and IBM cooperated to introduce the home "smart elderly care" program in Gulou District of Nanjing [28]. In 2011, according to Nanjing Daily, the "smart community grateful elderly care" service platform was opened in the future information hall of China Telecom Nanjing Branch [29]. In 2012, Modern Science covered the application of "smart Haidian" in Tsinghua Park street community hospital, Haidian District, Beijing [30]. In 2013, Population and Family Planning reported that the virtual elderly care home in Chengguan District, Lanzhou, Gansu, realized home elderly care [31]. In 2015, as covered in Fujian Daily, Fujian Vserve Technology Co., Ltd. established in 2010 designed the pattern of "internet + elderly care" which integrated systems such as "smart cloud health management", "smart institution elderly care" and "smart home elderly care". Its physiological demand orientation for the elderly and its corporate products were quite accurate [32].

Relevant academic studies have successively surfaced since 2013: Kim J (2013), after conducting a survey on 1,188 members of South Korean Gangnam Senior Plaza (GSP), manifested that high satisfaction degree resulted from desirable service facilities, convenient community services and education plan as well as friendly employees and clean equipment. GSP was deemed as the model of welfare services in South Korea [33]. Drobne S et. al (2014) analyzed the community service pattern for the elderly in Slovenia from 2000 to 2010, and developed proper elderly community care services in accordance with the plan, capital and the government's medical care and social security systems [34]. Hsu M S (2014) described Taiwan's Ming-Sheng Telecare U-care project in which smart health care services were realized through home gateway or interactive voice system and which could monitor life vital signs on a regular basis. Doctors would give prescriptions according to data. In the meantime, he mentioned that smart care service faced a number of challenges such as payment intention, maintenance ability and legal limitation [35]. WU Leilei (2014) took smart care for elderly in Shangcheng District of Hangzhou, Zhejiang, for example and applied the internet of things in home elderly care service [36]. XU Chao (2015) studied and analyzed concrete initiatives in the science & technology assistive action in Shanghai 96980 community service enter [37]. MAO Yu et. al (2015), based on ITAUT model, built a "one button" service user model, sorted out crucial factors and provided suggestions and countermeasures for smart elderly care service [38]. YUAN Xiaoliang (2016) conducted a survey on Z informationized elderly care service platform of X city and revealed that smart virtual elderly care service was confronted with many problems. Problems included implicit definition of services, improper differentiation of service objects, insufficient supply of supporting facilities and services, impact of traditional concept and hard-to-guarantee service quality, etc. [39].

DESIGN THOUGHTS FOR COMPREHENSIVE SOLUTION TO SMART CARE FOR THE ELDERLY

Further Analysis of Literature Data

Springer Link

It's found through retrieval of relevant research results that researches related with the key word "old people" focused on the medical field. The quotation times of the key word "the elderly" in papers was 834, ranking the first, followed by the word "old person" with a quotation quantity of 181[40] . Hence, this paper adopted "smart care for elderly" as the English equivalent. For the sake of more vivid analysis, we entered "SmartCare" + "Elderly" to search in Springer Link and the results were displayed as follows:

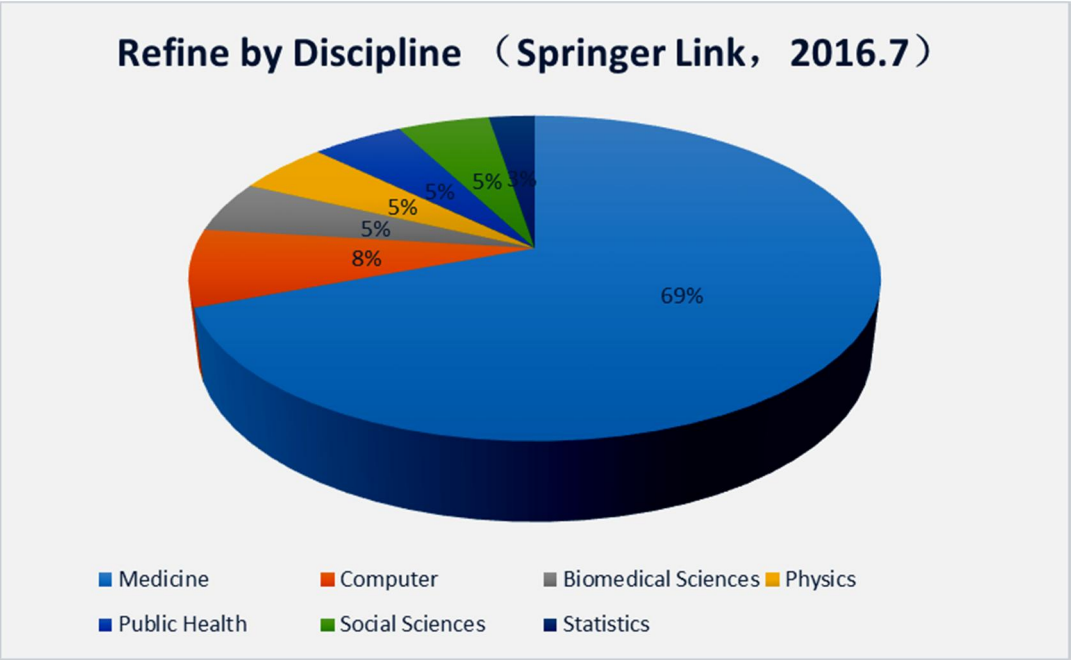

Figure 3: Layout of Relevant Discipline Papers in Springer (Data source: Springer Link Database, July 1, 2016)

As shown in the chart, 69% of foreign papers about "smart care for the elderly" centered on the medical field; 8% were about computer field and the remaining ones were scattered in other fields such as biomedicine, physics, public health, social sciences and statistics..

CNKI

According to annual retrieval data on CNKI theme words, before 2012, research achievements about "smart care for elderly" were touched upon in journal reports of varied elderly care systems. According to these studies, Japanese NEC's smart community were given greater attention by the media from 2011 to 2013. Starting from 2012, relevant academic papers were successively published. In recent years, the number of publications has taken on an upward trend and the number of published papers in 2016 is expected to exceed 200.

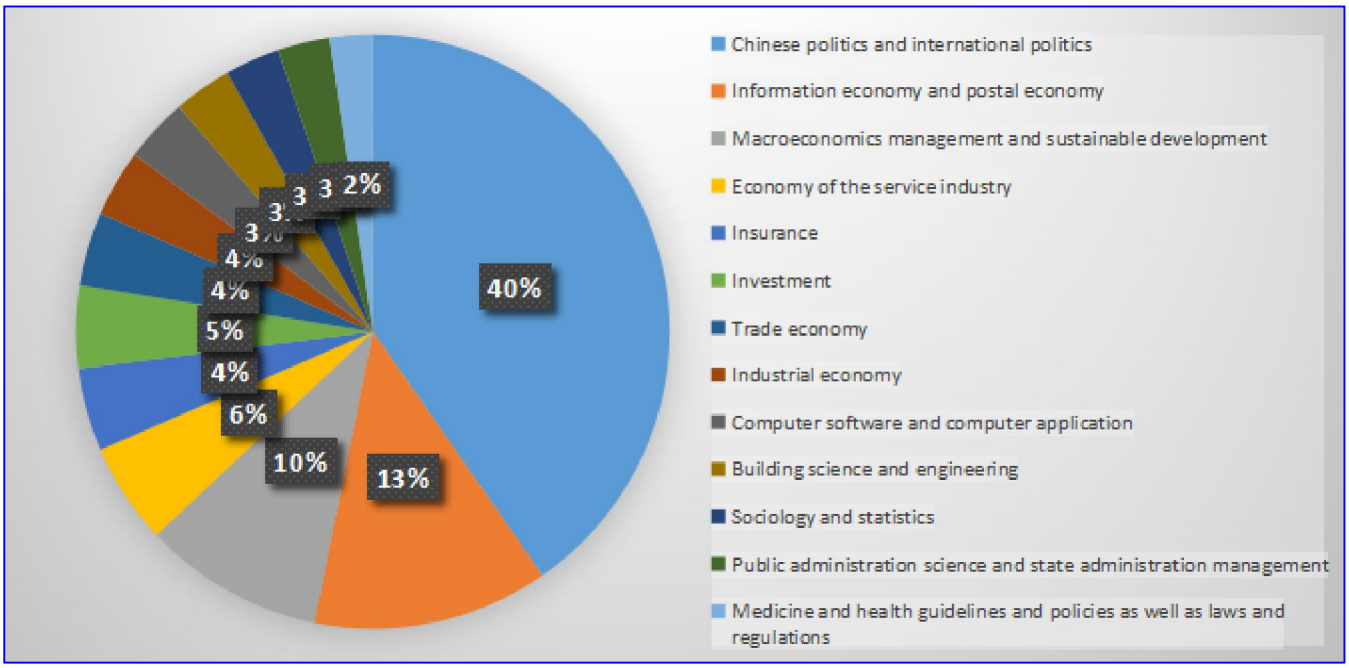

Figure 5: Discipline Retrieval Results in CNKI (Data source: CNKI http://www.cnki.net, July 1, 2016)

CNKI results and Springer results are widely different. It shows that 40% of Chinese scholars' papers are about politics, followed by information economy and macroeconomics; remaining papers mentioned economy of the service industry, insurance, investment, trade economy, industrial economy, computer software, computer application, building science and engineering, sociology and statistics, public administration science and medicine and health policy studies, etc. It means that most of studies on "smart care for elderly" in China's academic circle are still at the stage of humanistic and social science

while studies on applied sciences such as medicine and computer are just started.

Current research fields basically cover two aspects: first, technical application at an extremely microscopic level, emphasizing information technology field and belonging to the scope of specific functions of the network; second, extremely macroscopic theoretical studies which underline model exploration. Due to great span between the two aspects, it's hard to reach interdisciplinary conclusions. Yet, in actual application and under the greater environment of the internet, how to realize cohesion of relevant functions, construct and improve the smart care system for elderly, especially urgent need of the government for smart care for elderly comprehensive solution cannot be simply solved by technical masters or theoretical masters. Interdisciplinary studies pose higher requirements and challenges for scholars.

Analysis of Exiting Problems

At present, Chinese government attaches great importance to the status quo of population aging: on May 27, 2016, the CPC Central Committee Political Bureau held the 32nd collective study on China's aging population situation and countermeasures. The general secretary XI Jinping stressed to make greater efforts to improve the aging policy system, perfect policies such as support and maintenance for the elderly, social assistance, social welfare, social special treatment, livable environment and social participation, strengthen pertinence, coordination and systematicness of policies and systems, promote cohesion of varied policies and systems and consolidate resultant forces of policies [41]. As China has the largest population in the world, Chinese government is the greatest owner of medical health data. With years' construction, it has set up multiple platforms of medical health departments' business data. At the same time, macroscopic policy and environment are favorable. However, the following problems still exist in detailed research fields and applications:

Study Aspect

According to law of development, the academic study of scientific research institutions usually runs ahead of industrial applications. Due to the "trial and error" nature of academic studies, a certain failure rate is allowed for research projects. Nonetheless, products or applications of industries should press closer to market demands and their products should be mature to some extent out of pressure for development and survival. The two of them are both interdependent and contradictory. How to locate their cross part and conduct innovative industry-university-research studies shall be further considered.

System Aspect

First of all, existing health and care competent departments belong to different superiors and are restrained by modularized management system. Accordingly, their platforms cannot share each other's information. Complicated, non-shared and non-standard working procedures have reduced public satisfaction degree. Second, plenty of data are stacked in their own systems and most institutions fail to conduct data mining and analysis so data value is unable to be manifested yet.

Technical Aspect

It costs much to integrate different systems of a platform and there's no unified standard interface and standard system. Medical health systems in local places have been basically formed but a desirable model is in short in terms of extended services and data sharing. Problems exist such as precision of collected data by sensor (degree of closeness between measured value and real value, including precision and accuracy), and contradiction between portability of portable devices and hardware support. Concrete application of new technologies such as mobile internet, virtual reality, augmented reality and mix reality in the smart care for elderly field is yet to be explored. Besides, cloud computing based on the internet has raised higher requirements for software and hardware support.

Security Aspect

Information interaction and supplement between different medical care systems based on the internet as well as the platform service sharing model presented new requirements for smart care for the elderly in terms of security mechanism, management mechanism and empowerment mechanism. On the one hand, many relevant studies shall be conducted, including multi-system data aggregate, privacy protection of data storage, transmission and release, information security technology, data disturbance and anonymity generalization technology in the data storage step, concealment of personal private information, and other key technologies. On the other hand, relevant laws, regulations and policies regarding privacy protection and data security involved in the platform shall be able to avoid leakage of privacy while satisfying information demand, etc.

Solution Design

Based on previous scholars' studies and with combination of industrial application status and development trend, basic principles of solution design are as follows:

Collaborative Innovation Perspective

A solution framework which integrates data collection, data processing and integration, data analysis and data explanation shall be built from such perspectives as old people's psychological and physiological demands; further a set of management mechanism which consists of digital object identification, content aggregation and digital object retrieval should be formulated to realize smart analysis of elderly care data based on the internet, and enhance the coordination efficiency and level of different systems.

Interdisciplinary Perspective

Observation should be conducted from multiple disciplines such as medicine, computer science, electronic information engineering, management, economics and law. Besides, varied information technologies such as the internet of things and data mining shall be utilized to integrate multiple information systems of smart care for the elderly from the public governance perspective. Furthemore, a collaborative mechanism with heterogeneous network shall be designed, and professionalized and scientific analysis shall be conducted to provide comprehensive rational decision-making support for smart elderly care.

Mechanism and System Perspective

Studies should look for the coherence point between information technology and management mechanism, and profoundly probe into key technologies of the smart care for the elderly service platform. Under the prerequisite of improvement in security mechanism, management mechanism and empowerment mechanism, major attention shall be paid to data mining and product design and services for the development of regional smart elderly care industry so as to provide support for decision-making of governments, industries and institutions.

Preliminary design for concrete solutions can be seen in the following chart:

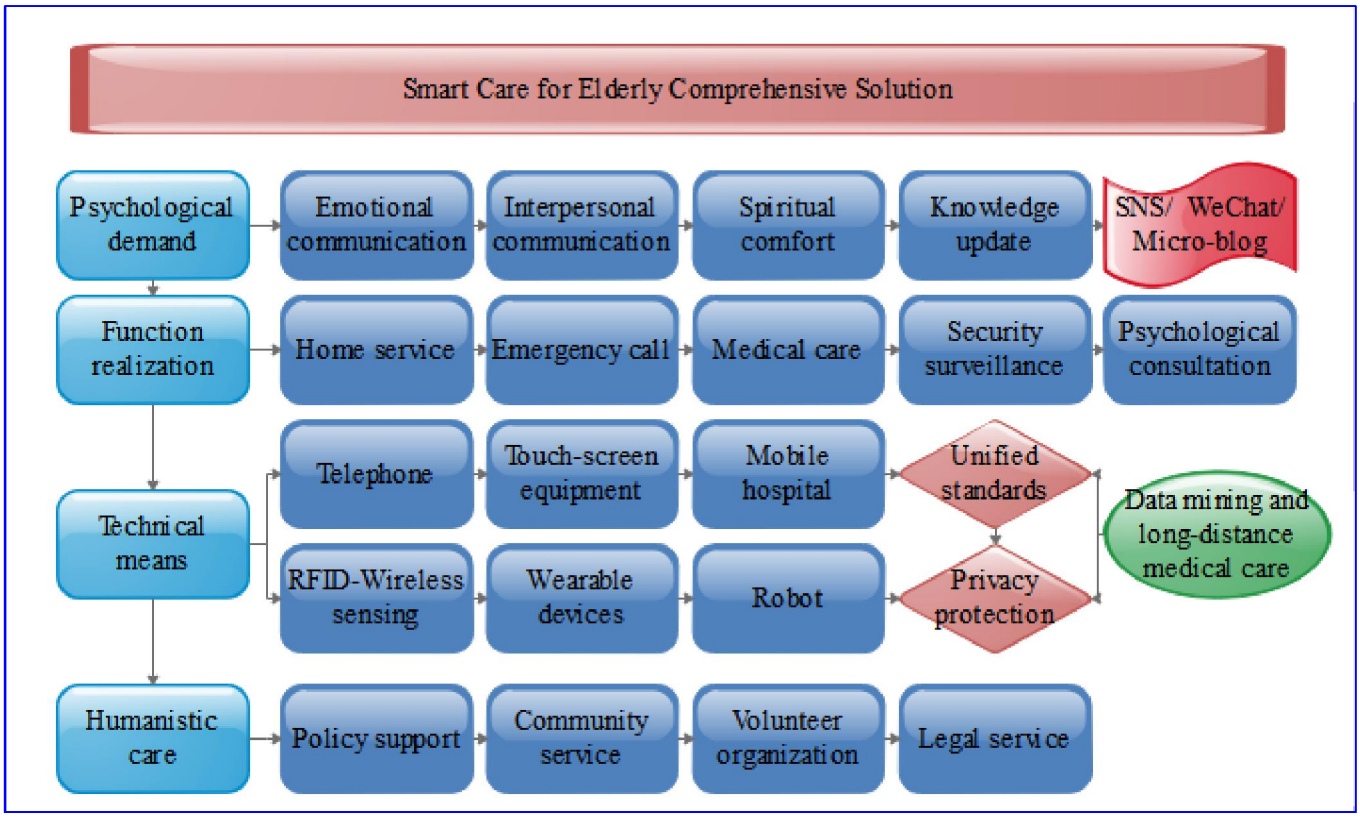

Figure 6: Smart Care for Elderly Comprehensive Solution

The solution stated above sticks to the basic path of platform design: demand analysis, prototype design, system testing and concrete application, etc; it starts with old people's psychological demands (emotional communication, interpersonal communication, spiritual comfort and knowledge update, etc.), and utilizes WeChat and micro-blog to work out functions which meet with old people's psychological demands above (home service, emergency call, medical care, security and health, and psychological consultation, etc.). Under the premise of unified standard and privacy protection, and to achieve the purpose of giving humanistic care to the elderly, ZUO used data mining and long-distance medical means as well as technical means (telephone, touch-screen devices, wireless sensing, wearable devices, robot and mobile hospital) to cooperate with policy support, community service, volunteer organization and legal service..

CONCLUSION

The development of the internet and new technologies has made it possible to have the elderly care service transform to the active service model "centering on patients" from the past passive pattern of seeking services by the elderly. As an important means, smart care for the elderly comprehensive solution combines information technology and humanistic and social sciences, and explores cross application of different disciplines and different technical means. Besides, it discusses varied features and rules in the development course of the elderly care industry, timely monitors, intervenes and manages varied elderly care services. All these are conducive to improving the cognition standard, treatment compliance and self-management abilities of the elderly and their families. By doing so, it will build a favorable interactive scenario and further enhance elderly care validity. Furthermore, it's of great practical significance to perfecting elderly care system of the entire society, gradually addressing the social aging problem and implementing China's elderly care policy of "prevention beforehand".

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APPENDIX

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